RFID BASED PETROL PUMP AUTOMATION SYSTEM

A Industry Oriented Mini Project Report

Submitted to

Jawaharlal Nehru Technological University Hyderabad

In partial fulfillment of the requirements for the

award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS & COMMUNICATION ENGINEERING

By

ANEM SAI KRISHNA (22VE5A0402)

Under the Guidance of

Mr. S. SUBRAHMANYAM

Assistant Professor

SREYAS
INSTITUTE OF ENGINEERING AND TECHNOLOGY
AUTONOMOUS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Approved by AICTE, New Delhi | Affiliated to JNTUH, Hyderabad | Accredited by NAAC "A" Grade & NBA | Hyderabad | PIN: 500068

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Certificate

This is to certify that the Industry Oriented Mini Project Report on ***"RFID BASED PETROL PUMP AUTOMATION SYSTEM"*** submitted by **ANEM SAI KRISHNA (22VE5A0402)** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics & Communication Engineering** from Jawaharlal Nehru Technological University, Kukatpally, Hyderabad for the academic year 2024-2025 is a record of Bonafide work carried out by him under our guidance and Supervision.

Guide	**Head of the Department**
Mr. S SUBRAHMANYAM	**Prof. CHINNAM S V MARUTHI RAO**

Project Coordinator	**Signature of the External Examiner**

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दिनांक / Date: 15/07/2024

Certificate

This is to certify that Mr. / Ms. Anem Sai Krishna son/daughter of Mr. Late Anem Yadaiah pursuing B.Tech in ECE from (College Name) Sreyas Institute of Engineering and Technology Roll No. 22VE5A0402 has successfully completed the Mini Project entitled/in the area of RFID Based Petrol Pump Automation System under our guidance. It is a bonafide work carried out by her/him from 15/05/2024 to 14/06/2024

He/She has completed the assigned module as per the requirements within the time frame. During the above period, the trainee's conduct was found Good

Project Coordinator

Centre Head

यह प्रमाण पत्र होलोग्राम लगा होने के साथ ही मान्य होगा / This Certificate shall be valid only with affixed hologram

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Declaration

I, **ANEM SAI KRISHNA**, bearing Hall Ticket No. **22VE5A0402** hereby declare that the Project titled "***RFID BASED PETROL PUMP AUTOMATION SYSTEM***" done by me under the guidance of **Mr. S. SUBRAHMANYAM**, which is submitted in the partial fulfillment of the requirement for the award of the B. Tech degree in **Electronics & Communication Engineering** at **Sreyas Institute of Engineering & Technology** for Jawaharlal Nehru Technological University, Hyderabad is my original work.

ANEM SAI KRISHNA (22VE5A0402)

ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without mention of the people who made it possible through their guidance and encouragement crowns all the efforts with success.

We take this opportunity to acknowledge with thanks and deep sense of gratitude to **Mr. S. SUBRAHMANYAM, Assistant Professor, Department of ECE** for her constant encouragement and valuable guidance during this work.

A Special note of Thanks to **Prof. CHINNAM S V MARUTHI RAO, Associate Professor and Head of the Department**, who has been a source of Continuous motivation and support in the completion of this project. He had taken time and effort to guide and correct us all through the span of this work.

We owe very much to the **Department Faculty, Principal** and the **Management** who made our term at Sreyas a Stepping stone for my career. We treasure every moment we had spent in the college.

Last but not least, our heartiest gratitude to our parents and friends for their continuous encouragement and blessings. Without their support this work would not have been possible.

ANEM SAI KRISHNA (22VE5A0402)

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ABSTRACT

Everything has been digitized. In many existing systems, almost all petrol pumps have a controlling unit to perform the tasks like managing the electrical pump, drive the display, measure the flow & accordingly turn OFF the electrical pump. But still a person is required to collect the money and there is a possibility of many human errors. In this proposed petrol pump automation system, we are using RFID card to access petrol at different petrol stations of different petrol companies across the country and here, we are connecting all these petrol stations using single web server. This web server access is secured by a password which is known only to the petrol companies. Whenever we want to fill the tank from the fuel dispenser, we just have to place the RFID card near the RFID reader. Then the microcontroller reads the data from the RFID reader and performs the action according to the customer requirements. This digital petrol pump system also provides the security for the customers for filling petrol at the Petrol stations by avoiding the involvement of human beings, hence reduces the risk of carrying money every time.

Keywords: RFID, Automation, Petrol Pump, Fuel Dispensing, Embedded System, RFID Tag, RFID Reader
Cashless Transaction

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CHAPTER 1

INTRODUCTION

In the rapidly evolving world of technology, automation has become a cornerstone for enhancing efficiency, accuracy, and user experience in various industries. The petroleum sector is no exception, where traditional fuel dispensing methods are being revolutionized through automation. The RFID-based petrol pump automation system is a cutting-edge solution designed to automate the fuel dispensing and payment process.

The main objective of this project is to reduce human labor by developing an auto-guiding system and implementing the operation in a squential manner.

This system leverages Radio Frequency Identification (RFID) technology to identify customers and vehicles automatically, enabling secure, cashless transactions and reducing human intervention. By integrating RFID with a robust backend system, it ensures seamless operations, prevents unauthorized access, and maintains accurate records of fuel usage.

The primary goal of this system is to improve operational efficiency, reduce waiting times, and provide a user-friendly experience to customers, while also minimizing errors and fraud. It is an innovative step toward modernizing fuel stations and adapting to the growing demand for smart and automated solutions.

1.1 Objectives of the project

Automate Fuel Dispensing: Streamline the fuel dispensing process by automatically identifying authorized vehicles or customers using RFID technology.

Enhance Transaction Security: Ensure secure and cashless transactions by linking RFID tags with prepaid accounts or bank systems.

Reduce Human Intervention: Minimize manual operations to improve efficiency and reduce the likelihood of human errors.

Provide Real-Time Transaction Data: Maintain detailed and accurate records of fuel transactions, including date, time, quantity, and balance.

Increase Operational Efficiency: Decrease waiting times by enabling faster identification and processing of fuel requests.

Prevent Fuel Misuse or Theft: Ensure only authorized vehicles or customers receive fuel, reducing unauthorized access or fraud.

Support Cashless Payments: Facilitate modern payment systems by integrating RFID with prepaid balances or digital wallets.

Improve Customer Convenience: Offer a seamless and user-friendly experience by eliminating the need for manual cash payments or traditional identification methods.

1.2 Overview

An RFID-based petrol pump automation system is a technology-driven solution designed to automate the process of fuel dispensing, enhance operational efficiency, and provide a seamless, secure experience for users. The system uses Radio Frequency Identification (RFID) technology to identify vehicles, authorize transactions, and facilitate cashless payments, eliminating the need for manual intervention.

Key Concepts:

RFID Technology:

- RFID tags are attached to vehicles and carry unique identification data.
- An RFID reader scans these tags to identify the vehicle and fetch associated account information.

Automation:

- Automates the entire fuel-dispensing process, from vehicle identification to payment.
- Minimizes human error and speeds up transactions.

Cashless Transactions:

- Links user accounts or prepaid wallets for automatic payment deduction.

Seamless Integration:

- Connects to a centralized database to store user details, transaction history, and fuel consumption records.

CHAPTER 2

LITERATURE SURVEY

RFID-based petrol pump automation systems have been extensively researched as a means to enhance efficiency, security, and convenience in fuel management. Studies show that RFID technology automates fuel dispensing, reduces manual errors, and supports cashless payments, offering a seamless experience for users. Its integration with centralized databases ensures accurate transaction logging and prevents unauthorized access, enhancing security. Applications in fleet management demonstrate real-time monitoring of fuel consumption, while scalability studies highlight the system's potential for large-scale implementation. Despite challenges like high initial costs, RFID-based automation is a robust and reliable solution with future prospects in IoT and AI integration for smarter fuel management.

1. Automation in Fuel Dispensing

- **Study Title**: *Automation in Petrol Stations Using RFID Technology*
- **Key Findings**:
    - RFID systems can effectively automate fuel dispensing, reducing manual errors and improving transaction speed.
    - Integration of RFID with databases ensures accurate user identification and transaction logging.
- **Contribution**: Highlighted the time-saving potential of RFID systems in public and private fuel stations.

2. Enhanced Security

- **Study Title**: *Improving Fuel Station Security Using RFID Technology*
- **Key Findings**:

- RFID-enabled systems reduce unauthorized fuel access by ensuring only registered vehicles can refuel.
- Authentication using unique RFID tags linked to user accounts significantly reduces fuel theft.

- **Contribution**: Demonstrated that RFID enhances operational security compared to conventional systems.

3. Cashless Payment Integration

- **Study Title**: *Cashless Transactions at Fuel Stations: An RFID Approach*
- **Key Findings**:

- RFID systems enable seamless integration with digital wallets or prepaid accounts.
  - Cashless systems reduce queue times and eliminate issues related to cash handling.
  - **Contribution**: Validated that cashless RFID systems are efficient and user-friendly.

4. Fleet Management

- **Study Title**: *RFID for Fuel Monitoring in Fleet Management*
- **Key Findings**:

- RFID systems are beneficial for fleet operators to monitor fuel consumption and refueling patterns.
- Real-time data from RFID tags aids in optimizing fleet operations and cost management.

- **Contribution**: Highlighted the role of RFID in tracking and auditing fuel usage in commercial fleets.

CHAPTER 3

METHODOLOGY AND ALGORITHM USED

3.1 METHODOLOGY

1. **System Initialization**:

- The database is populated with registered user and vehicle details.The RFID reader and tag system are configured.

2. **Vehicle Identification**:

- The vehicle's RFID tag is scanned by the RFID reader when it approaches the pump.
- The system retrieves the user's account and vehicle information from the database.

3. **Authentication**:

- The unique RFID tag ID is matched with the database records to verify the user.
- If authentication fails, the system denies access.

4. **Fuel Dispensing**:

- The user specifies the desired fuel quantity or amount.
- The pump dispenses fuel as per the input after verifying the available balance.

5. **Payment Processing**:

- The corresponding amount is deducted from the linked account or prepaid wallet.

6. **Transaction Logging**:

- Details such as the date, time, fuel quantity, and amount are recorded in the database.
- A confirmation message is sent to the user via SMS or email.

7.**System Reset**:

- After the transaction is complete, the system resets for the next user.

3.2 ALGORITHM

Step 1: Initialize the system components (RFID reader, microcontroller, database, and fuel pump).

Step 2: Detect the presence of a vehicle by reading the RFID tag.

Step 3: Authenticate the RFID tag by matching its ID with the database.

- If the ID is valid, proceed to Step 4.
- If the ID is invalid, deny access and display an error message.

Step 4: Retrieve user details and display the available balance on the screen.

Step 5: Accept user input for fuel quantity or cost.

Step 6: Check if the user's account balance is sufficient:

- If yes, proceed to Step 7.
- If no, deny the transaction and prompt the user to recharge the account.

Step 7: Activate the fuel pump and dispense fuel as per the user's request.

Step 8: Deduct the corresponding amount from the user's account.

Step 9: Log the transaction details (fuel quantity, amount, and time) into the database.

Step 10: Notify the user via SMS or email about the completed transaction.

Step 11: Reset the system and prepare for the next user.

CHAPTER 4

IMPLEMENTATION DETAILS

4.1 Block diagram

The system begins with the RFID reader scanning the tag on the vehicle and passing the ID to the microcontroller. The microcontroller verifies this ID with the database system to authenticate the user. Upon verification, the user provides input via the user interface for the fuel quantity or cost. The microcontroller controls the fuel pump to dispense the requested fuel while interacting with the payment system to deduct the corresponding amount from the user's account. The system logs the transaction in the database and sends a confirmation notification to the user through the notification system. The entire setup is powered by a reliable power supply.

This modular structure ensures smooth and efficient operation of the automation system.

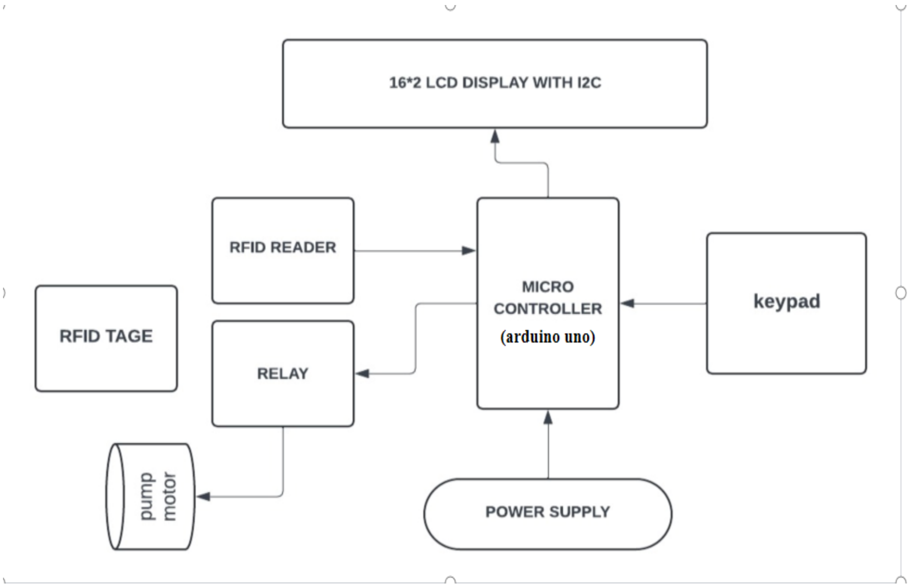

Fig 4.1: BLOCK DIAGRAM

- **RFID TAGE:**

  An RFID (Radio Frequency Identification) tag is a small device used to store and transmit data wirelessly through radio waves. It is a key component of RFID-based systems, including petrol pump automation, where it is attached to vehicles for identification and authentication.

- **RFID READER:**

  An RFID Reader is a device that communicates with RFID tags to identify, authenticate, and retrieve information stored in them. In an RFID-based petrol pump automation system, the RFID reader is a critical component that interacts with the vehicle's RFID tag to initiate the fuel dispensing process.

- **RELAY:**

  A relay is an electrically operated switch that allows low-power signals to control high-power circuits. In RFID-based petrol pump automation systems, relays are used to control the activation of the fuel pump based on signals received from the microcontroller, ensuring precise and automated operation.

- **PUMP MOTOR**

  A pump motor is an essential component in an RFID-based petrol pump automation system, responsible for dispensing fuel to vehicles. The motor drives the fuel pump mechanism, ensuring accurate and controlled delivery of fuel as per user requirements.

- **16x2 LCD DISPLAY WITH 12C**

  A 16x2 LCD display with I2C is a widely used component for displaying alphanumeric data in embedded systems, including RFID-based petrol pump automation systems. It simplifies communication between the microcontroller and the LCD, reducing the number of pins required and enabling efficient data transmission.

- **MICROCONTROLLER (Arduino Uno):**

  The Arduino Uno is a widely-used microcontroller board based on the ATmega328P microchip. It serves as the central processing unit in various embedded systems, including the RFID-based petrol pump automation system, where it handles input from RFID readers, controls the fuel pump, manages displays, and communicates with databases or payment systems.

- **POWER SUPPLY:**

  In an RFID-based petrol pump automation system, the power supply is responsible for providing the necessary electrical energy to all components such as the Arduino Uno, RFID reader, LCD display, relay, and pump motor. A reliable power supply ensures the system runs smoothly and efficiently, preventing component failure due to voltage fluctuations.

- **KEYPAD:**

  A keypad is a crucial input device in an RFID-based petrol pump automation system. It allows the user to input commands or settings, such as entering the fuel amount, verifying the pump selection, or entering a PIN code for authentication in some systems.

4.2 SYSTEM DESIGN:

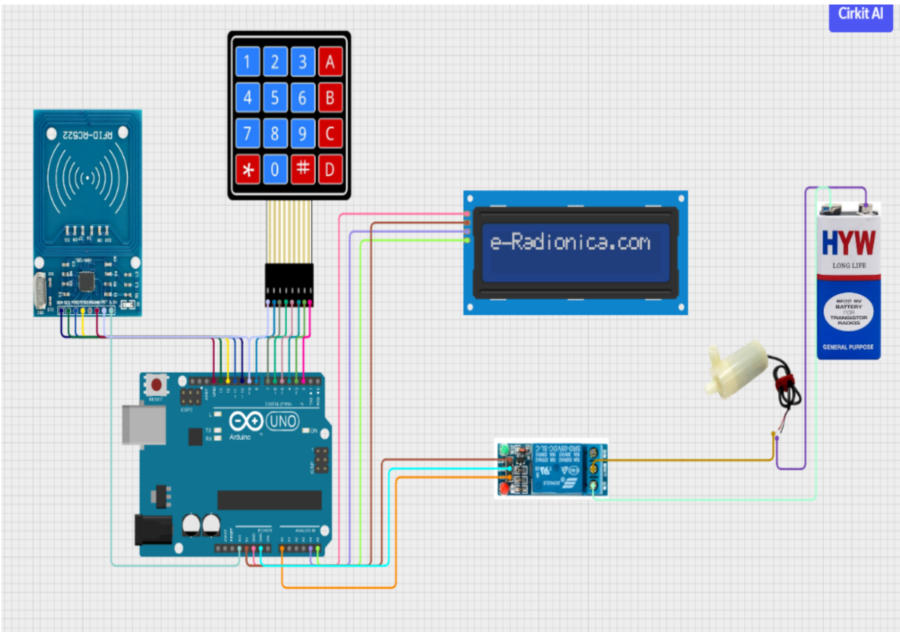

Fig 4.2. schematic diagram of RFID based petrol pump automation system

Basic Schematic Diagram Description

Here's a simple description of the schematic for this syst

1. **Arduino Uno:**

- VCC (5V) → Powers the Arduino, RFID reader, keypad, and LCD display.
- GND → Common ground for all components.
- Pins 2-5 → Connected to the rows of the 4x4 keypad.
- Pins 6-9 → Connected to the columns of the 4x4 keypad.
- TX/RX → Connected to the RFID reader for data transmission.
- Pin 7 → Controls the relay.

2. **Relay:**

- Control Pin (7) → Connected to the Arduino to turn the relay on or off.
- COM Terminal → Connected to fuel pump motor's power line (e.g., 12V or 24V).

- NO Terminal → Connected to the fuel pump motor for powering it on when the relay is activated.

3. **Fuel Pump Motor:**

- Powered by a separate 12V/24V DC power supply.
- Controlled by the relay to start/stop dispensing fuel.

4. **LCD Display:**

- Connected via SDA and SCL pins to the Arduino Uno for display functionality.

5. **Keypad:**

- Connects to digital pins 2-5 (rows) and pins 6-9 (columns) on the Arduino Uno.

6. **RFID Reader:**

- Powered via the 5V pin on the Arduino Uno.
- Data transmitted to the Arduino Uno for authentication.

7. **Power Supply:**

- A 5V regulated supply for the Arduino Uno, keypad, LCD, and RFID reader.
- A 12V/24V DC supply for the fuel pump motor.

CHAPTER 5
OVERVIEW OF HARDWARE TOOLS USED

In this chapter, the hardware tools that are used to construct the circuit is explained and how to install software required.

5.1 Arduino Uno

The Arduino Uno is a popular microcontroller board widely used in embedded systems, IoT applications, and automation projects. Based on the ATmega328P microcontroller, it is a versatile, user-friendly, and affordable platform that simplifies prototyping and development. The Uno is particularly suitable for projects like the RFID-based petrol pump automation system, where it acts as the control unit, managing inputs, processing data, and controlling outputs.

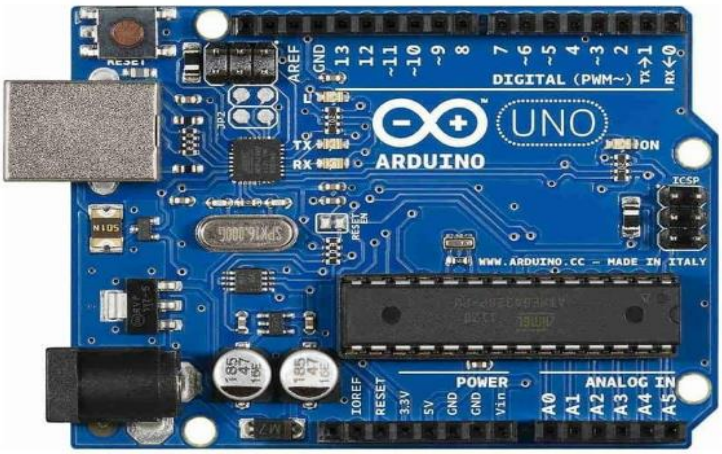

Fig 5.1 Arduino Uno Pin Diagram

5.1.1 Key Features of Arduino Uno

Feature	Description
Microcontroller	ATmega328P (8-bit AVR RISC-based microcontroller)
Operating Voltage	5V
Input Voltage (Recommended)	7-12V
Input Voltage (Limit)	6-20V
Digital I/O Pins	14 (of which 6 can provide PWM output)
PWM Pins	6 (Pins: 3, 5, 6, 9, 10, 11)
Analog Input Pins	6 (Pins: A0 to A5)
DC Current per I/O Pin	20 mA
Flash Memory	32 KB (0.5 KB used by bootloader)
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
USB Interface	USB Type-B connector for programming and power
Communication	UART (Serial), SPI, I2C
LED Indicator	Built-in LED on Pin 13
Power Options	USB, DC barrel jack, or Vin pin
Reset Button	Onboard reset button for restarting the microcontroller
Dimensions	68.6 mm x 53.4 mm
Weight	Approx. 25 grams
Compatibility	Compatible with most Arduino shields and open-source software (Arduino IDE)

Table 5.1.1 Key Features of Arduino Uno

5.1.2 Pin Configuration Table

Pin Number	Pin Name	Type	Function
0	RX	Digital I/O	UART Receive
1	TX	Digital I/O	UART Transmit
2-13	D2-D13	Digital I/O	General-purpose input/output
3, 5, 6, 9-11	PWM	Digital PWM	Pulse Width Modulation output
A0-A5	Analog Input	Analog	Reads analog signals (10-bit resolution)
VIN	Power	Voltage Input	Input for external power supply
5V, 3.3V	Power	Voltage Output	Provides regulated power to external devices
GND	Power	Ground	Common ground for all components
RESET	Control	Reset Signal	Resets the Arduino board
SCL (A5)	I2C Clock	Communication	Serial Clock for I2C devices
SDA (A4)	I2C Data	Communication	Serial Data for I2C devices
MOSI (D11)	SPI Data	Communication	Master Out Slave In for SPI communication
MISO (D12)	SPI Data	Communication	Master In Slave Out for SPI communication
SCK (D13)	SPI Clock	Communication	SPI Clock
SS (D10)	SPI Control	Communication	Slave Select

TABLE 5.1.2 PIN CONFIGURATION TABLE

5.2 RFID READER

An **RFID Reader** is a device used to read data stored on RFID tags. It plays a critical role in systems such as the **RFID-based petrol pump automation system**, where it identifies vehicles or users by scanning their RFID tags. The RFID reader communicates with the microcontroller (e.g., Arduino Uno) to process the data and authenticate the user.

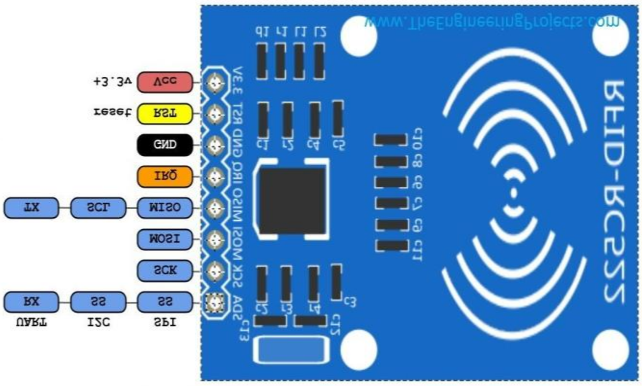

FIG 5.2 RFID READER

How RFID Readers Work

1. **Emission of Radio Waves**: The RFID reader emits radio waves through its antenna to power and communicate with nearby RFID tags.
2. **Tag Detection**: When an RFID tag enters the reader's range, it absorbs energy from the emitted waves, activating the tag's microchip.
3. **Data Retrieval**: The tag sends its unique identification number (UID) or stored data back to the reader using electromagnetic waves.

4. **Data Processing**: The reader interprets the received data and sends it to a connected microcontroller or computer system for authentication and processing.

Types of RFID Readers

1. **Passive RFID Readers**:
   - Operates with passive RFID tags (no internal battery).
   - Relies on the radio waves emitted by the reader to power the tag.
   - Suitable for short-range applications.
2. **Active RFID Readers**:
   - Works with active RFID tags that have their own power source (battery).
   - Supports long-range communication.
3. **Fixed and Handheld RFID Readers**:
   - **Fixed Readers**: Mounted in a specific location for continuous scanning.
   - **Handheld Readers**: Portable devices for on-the-go tag reading.

RFID Reader Specifications

Specification	**Description**
Operating Frequency	Commonly 125 kHz (low frequency) or 13.56 MHz (high frequency).
Communication Interface	UART (Serial), SPI, or I2C for communication with microcontrollers.
Range	Passive tags: 5-10 cm; Active tags: up to several meters.

Specification	Description
Power Supply	Typically 3.3V or 5V (compatible with Arduino and similar boards).
Protocol	Supports protocols like ISO/IEC 14443 or ISO/IEC 15693.

TABLE 5.2.1 RFID Reader Specifications

RFID Reader in Petrol Pump Automation System

- **Role**: The RFID reader scans the vehicle's RFID tag when it approaches the pump. It sends the tag's UID to the microcontroller for authentication.
- **Process**: If the tag matches an authorized entry in the system database, the transaction proceeds. Otherwise, access is denied.
- **Integration with Arduino**: RFID readers, such as the **RC522**, can be easily interfaced with the Arduino Uno using SPI or UART communication.

5.3 RFID Card

An RFID card is a type of contactless identification card embedded with an RFID tag that stores data in the form of a unique identifier or user-specific information. These cards are widely used in applications such as access control, payment systems, and automation systems like the RFID-based petrol pump automation system, where they facilitate secure and efficient vehicle or user identification.

FIG 5.3 RFID Card

Components of an RFID Card

1. **Microchip**:
   - Stores the unique identification number (UID) or other data.
   - Controls the communication with the RFID reader.
2. **Antenna**:
   - A coil embedded in the card that enables communication with the RFID reader by transmitting and receiving radio frequency signals.
3. **Substrate**:
   - The physical structure of the card, typically made of PVC or plastic, which houses the chip and antenna.

Types of RFID Cards

1. **Passive RFID Cards**:
   - No internal power source (battery).
   - Operates by drawing power from the RFID reader's radio waves.

- Commonly used in access control and automation systems.

2. **Active RFID Cards**:
- Contains an internal battery for powering the chip.
- Supports longer reading ranges compared to passive cards.

Specifications of RFID Cards

Parameter	Description
Frequency	Common frequencies are **125 kHz** (Low Frequency) or **13.56 MHz** (High Frequency).
Range	Passive cards: 5-10 cm; Active cards: up to a few meters.
Memory Capacity	Typically ranges from **64 bytes to 4 KB**.
Standards Supported	ISO/IEC 14443, ISO/IEC 15693, or other RFID standards.

TABLE 5.3.1 Specifications of RFID Cards

How RFID Cards Work

1. **Activation**:
When the RFID card is brought near an RFID reader, the reader emits electromagnetic waves to activate the card's antenna and power its microchip.

2. **Data Transmission**:
The microchip in the card responds by sending its stored

data (UID or other information) to the RFID reader through electromagnetic waves.

3. **Processing**:

The reader captures the transmitted data and sends it to a connected system (e.g., a microcontroller) for authentication or processing.

Role in RFID-Based Petrol Pump Automation System

1. **Vehicle/Customer Identification**:

- Each vehicle or customer is assigned an RFID card that serves as a unique identifier.

2. **Authentication**:

- When the RFID card is presented to the reader, the system verifies the UID against a database of authorized users.

3. **Transaction Initiation**:

- Upon successful authentication, the user can proceed with fueling, ensuring a secure and automated process.

5.4 4x4 matrix keypad

A 4x4 matrix keypad is a type of input device commonly used in embedded systems and microcontroller projects. It consists of 16 keys arranged in four rows and four columns. These keypads are often used for numerical input, such as in calculators, security systems, or control panels.

Structure of a 4x4 Matrix Keypad

1. **Rows and Columns**:

- The 16 keys are interconnected in a matrix format with **4 rows** (R1–R4) and **4 columns** (C1–C4).

2.**Keys**:

- Each key represents a unique combination of a row and a column. For example, pressing key '5' connects **Row 2 (R2)** and **Column 2 (C2)**.

3.**Connection Pins**:

- The keypad has **8 pins**: 4 for rows and 4 for columns, which connect to the microcontroller.

FIG 5.4 4x4 matrix keypad

WORKING PRINCIPLE:

- **Connections:** The keypad has 8 pins: 4 for rows and 4 for columns. When a key is pressed, it creates a connection between the respective row and column.
- **Key Detection:**
  Scanning: Microcontrollers sequentially send signals (e.g., HIGH or LOW) to the rows while reading the columns. If a signal appears on a column pin, it indicates which key was pressed by matching the active row and column.
- **Matrix Logic:**
  For instance, pressing '5' connects R2 to C2.

How a Matrix Keypad Works

1. **Scanning Rows and Columns**:
   - The microcontroller outputs signals on rows and scans for input on columns (or vice versa).
   - When a key is pressed, it completes the circuit between a specific row and column.
2. **Identifying the Key Pressed**:
   - By detecting which row and column are connected, the system determines the key pressed.
   - For instance, if **R2** and **C3** are active, the key '6' is pressed.

4x4 Keypad Specifications

Parameter	**Description**
Dimensions	Varies; typically compact.
Operating Voltage	3.3V–5V.
Number of Buttons	16.
Connection Pins	8 (4 for rows, 4 for columns).
Material	Plastic or silicone keys.
Interface	GPIO pins of a microcontroller.

TABLE 5.4.1 4x4 Keypad Specifications

5.5 RELAY MODULE

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operation.

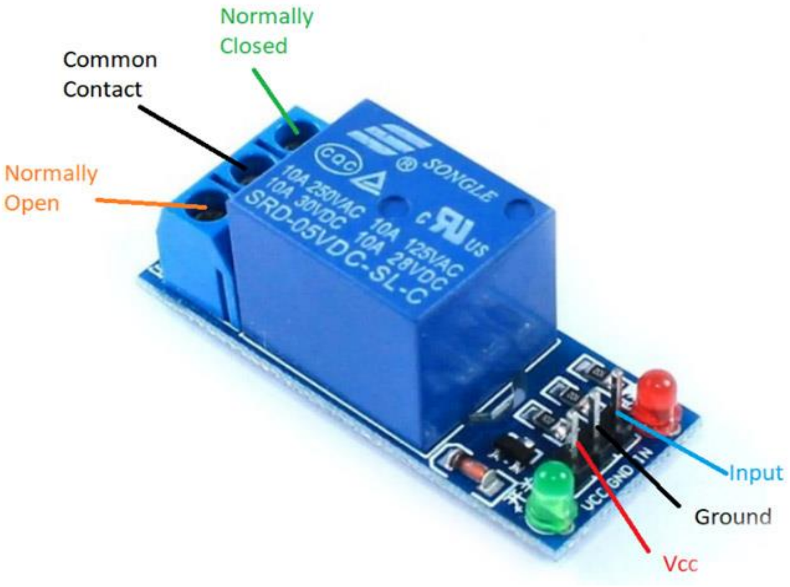

Fig 5.5 Relay

Specifications:

- Normal Voltage is 5V DC
- Normal Current is 70mA
- AC load current Max is 10A at 250VAC or 125V AC
- DC load current Max is 10A at 30V DC or 28V DC

- It includes 5-pins & designed with plastic material
- Operating time is 10msec
- Release time is 5msec
- Maximum switching is 300 operating per minute

5.6 Liquid Crystal Displays (LCD)

The Liquid Crystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver. There are many of them out there, and you can usually tell them by the 16-pin interface.

Fig5.6 LCD

The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The interface consists of the following pins:

A register select (RS) pin that controls where in the LCD's memory you're writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next.

- A Read/Write (R/W) pin that selects reading mode or writing mode
- An Enable pin that enables writing to the registers
- 8 data pins (D0 -D7). The states of these pins (high or low) are the bits that you're writing to a register when you write, or the values you're reading when you read.

The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires seven I/O pins from the Arduino, while the 8-bit mode requires 11 pins. For displaying text on the screen, you can do most everything in 4-bit mode, so example shows how to control a 16x2 LCD in 4-bit mode.

SPECIFICATIONS:

- Operating Voltage: 4.7V to 5.3V
- Operating Current :1mA
- Can display (16x2) 32
- Alphanumeric Characters
- Custom Characters Support
- Works in both 8-bit and 4-bit Mode

5.7 PUMPING MOTOR:

A **pumping motor** is an electric motor used to drive a pump, enabling the movement of fluids like water, fuel, or oil. In the context of an **RFID-based petrol pump automation system**, the pumping motor is a key component that dispenses fuel after successful authentication.

FIG 5.7 PUMPING MOTOR

Specifications of a Typical Pumping Motor:

Parameter	**Description**
Voltage Rating	DC (5-24V) or AC (110V/220V), depending on application.
Current Rating	Depends on the motor size and load requirements.
Power Rating	Varies from a few watts to several kilowatts.
Flow Rate	Determines the speed of fuel dispensing (e.g., liters/min).
Control	Can be controlled using relays, motor drivers, or microcontrollers.

TABLE 5.7.1 Specifications of a Typical Pumping

Connection with Microcontroller (Arduino):

To control the pumping motor with an Arduino or other microcontrollers:

1. **Relay Module**:
   - Use a relay to control high-power motors. The Arduino sends a signal to the relay, which switches the motor ON or OFF.
2. **Motor Driver**:
   - For DC motors, a driver module like **L298N** can be used to control the motor's speed and direction.

Circuit Diagram:

The pumping motor is typically connected to the system as follows:

1. **Arduino Pin**: Sends a control signal.
2. **Relay Module or Motor Driver**: Activates or deactivates the motor.
3. **Power Supply**: Powers the motor directly (not through the Arduino).
4. **Motor**: Dispenses the fuel.

5.8 I2C(Inter-Integrated Circuit):

I2C (Inter-Integrated Circuit) is a communication protocol used for exchanging data between a microcontroller and peripheral devices like sensors, displays, and memory modules. It is particularly useful in embedded systems due to its simplicity and efficient use of pins. In the context of an RFID-based petrol pump automation system, I2C may be used to interface components such as an LCD display, EEPROM, or other I2C-enabled devices.

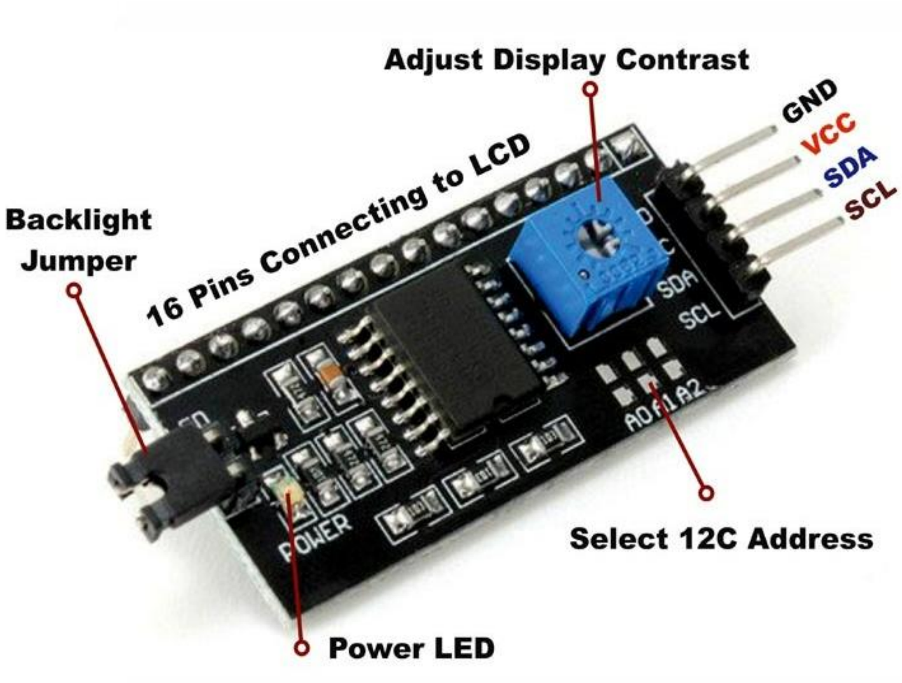

FIG 5.8 I2C(Inter-Integrated Circuit):

Key Features of I2C

1.**Two-Wire Communication**:

- **SDA (Serial Data Line)**: Transfers data.
- **SCL (Serial Clock Line)**: Synchronizes data transfer.

2.**Master-Slave Architecture**:

- The **master** (e.g., a microcontroller) initiates communication and controls the clock.
- The **slave** devices respond to master's requests.

3.**Multiple Devices**:

- Supports multiple slave devices on the same bus, identified by unique **7-bit or 10-bit addresses**.

4.**Bidirectional Data**:

- Allows data to be sent and received on the SDA line.

Specifications:

Feature	Description
Bus Speed	Standard (100 kHz), Fast (400 kHz), or more.
Number of Devices	Up to 128 devices on a single bus.
Wiring	Two lines (SDA, SCL) and common ground.

TABLE 5.8.1 SPECIFICATION I2C

How I2C Works:

1. **Start Condition**:
   - The master generates a start signal by pulling SDA low while SCL remains high.
2. **Addressing**:
   - The master sends the 7-bit address of the slave it wants to communicate with, followed by a read/write bit.
3. **Acknowledgment (ACK)**:
   - The addressed slave responds with an ACK by pulling SDA low.
4. **Data Transfer**:
   - Data is transferred byte by byte, with an ACK from the receiver after each byte.
5. **Stop Condition**:
   - Communication ends when the master releases SDA after pulling SCL high.

5.9 I2C CONNECTED WITH LCD DISPLAY

An **I2C-enabled LCD display** simplifies interfacing with microcontrollers like Arduino. Instead of requiring multiple pins for communication (as in a standard parallel LCD interface), an I2C module reduces the connections to just two wires: **SDA (Serial Data)** and **SCL (Serial Clock)**, plus power connections (**VCC** and **GND**).

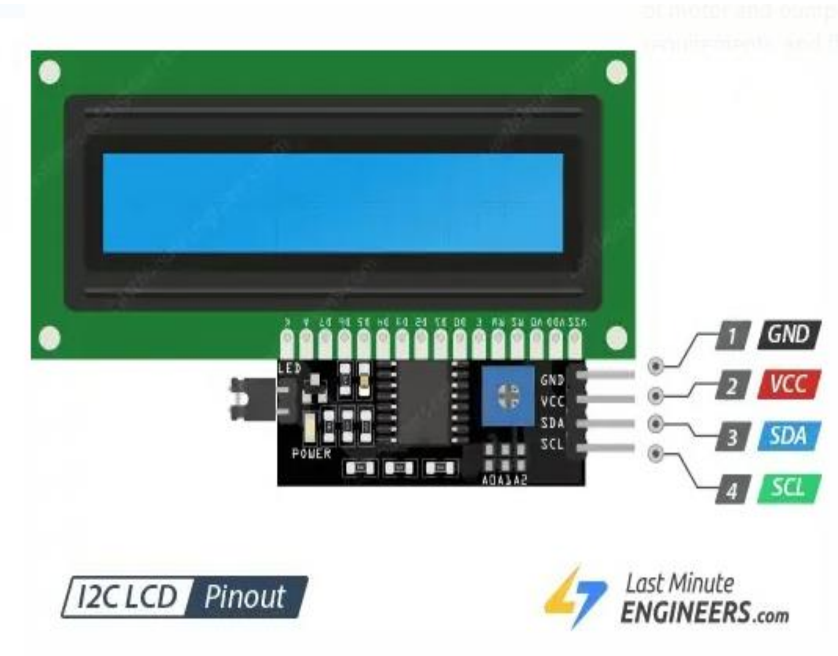

FIG 5.9 I2C CONNECTED WITH LCD DISPLAY

Pin Configuration of I2C LCD:

Pin Name	**Description**
VCC	Power supply (+5V).
GND	Ground.
SDA	Serial Data Line.
SCL	Serial Clock Line.

TABLE 5.9.1 Pin Configuration of I2C LCD:

Steps to Connect an I2C LCD to an Arduino:

1. **HardwareConnections**:

Connect the I2C module pins to the Arduino as follows:

I2C LCD Pin	Arduino Uno Pin
VCC	5V
GND	GND
SDA	A4
SCL	A5

2. **Install the Required Library**:

- Use the **LiquidCrystal_I2C** library for Arduino.
- Install it via the Arduino IDE's Library Manager: **Sketch > Include Library > Manage Libraries**, and search for "LiquidCrystal_I2C."

3. **Identify the I2C Address**:

- Use an **I2C scanner sketch** to find the address of your LCD module (commonly 0x27 or 0x3F).

How the I2C LCD Works in an RFID-Based Petrol Pump System:

1. **Display Information**:

- **Authentication Status**: Shows messages like *"Card Verified"* or *"Access Denied."*
- **Fuel Dispensing Data**: Displays fuel quantity, price, or remaining balance.

2. **User Guidance**:

- Prompts users to scan RFID cards or enter data via a keypad.

3.**Real-Time Updates**:

- Dynamically updates as transactions are processed.

5.10 BATTERY

A **battery** is a crucial component in embedded and automation systems, providing a stable and reliable power supply. In an **RFID-based petrol pump automation system**, the battery may serve as the primary or backup power source, ensuring uninterrupted operation, especially in case of power outages.

FIG 5.10 BATTERY

Role of the Battery:

1.**Primary Power Source**:

- Supplies energy to the microcontroller, RFID reader, LCD, pump motor, and other components if the system is not connected to mains power.

2.**Backup Power**:

- Ensures the system continues to function during power cuts, maintaining security and transaction continuity.

3.**Portability**:

- Allows the system to operate in remote or mobile settings, such as portable fuel dispensers.

Battery Types:

Type	Features	Applications
Lead-Acid	Affordable, high capacity, heavy.	Backup power for stationary systems.
Lithium-Ion (Li-ion)	Lightweight, rechargeable, long life.	Portable or compact systems.
Lithium Polymer (Li-Po)	Flexible shape, high energy density.	Advanced, lightweight systems.
Nickel-Metal Hydride (NiMH)	Affordable, moderate capacity.	Older systems or low-power designs.

TABLE 5.10.1 Battery Types

Battery Specifications:

Parameter	Description
Voltage Rating	Typically 5V, 7.4V, or 12V for embedded systems.
Capacity	Measured in mAh or Ah (determines runtime).
Rechargeability	Determines if the battery can be recharged.
Weight	Important for portable systems.

TABLE 5.10.2 Battery Specifications:

Connection with the System

1. **Power Regulation**:
   - A **voltage regulator** (e.g., LM7805 or buck converter) ensures stable output voltage for components like Arduino and RFID reader.
2. **Wiring**:
   - Positive (+) terminal of the battery connects to the input of the voltage regulator.
   - Negative (-) terminal connects to the ground of the circuit.
3. **Charging Circuit** (if rechargeable):
   - Use a charging module like TP4056 for Li-ion or Li-Po batteries.

CHAPTER 6

WORKING

An **RFID-based petrol pump automation system** automates the fuel dispensing process by leveraging RFID technology and microcontroller-based control. When a vehicle arrives at the petrol pump, an RFID reader scans the unique RFID tag assigned to the vehicle, which contains pre-stored identification data. The system authenticates the tag by cross-checking it with a database of authorized users. Once validated, the user can input the desired fuel quantity via a keypad or proceed with pre-assigned fuel limits. The microcontroller processes the request, activates a relay to start the fuel pump motor, and begins dispensing fuel. A display provides real-time updates on the amount of fuel dispensed and the transaction status. The system ensures precision by automatically stopping the pump once the desired quantity is reached, preventing over-dispensing. Additionally, transaction details are logged for record-keeping, and optional features like PIN authentication or receipt generation enhance security and convenience. This automation reduces manual intervention, enhances accuracy, and provides a secure, efficient, and user-friendly solution for petrol pump operations.

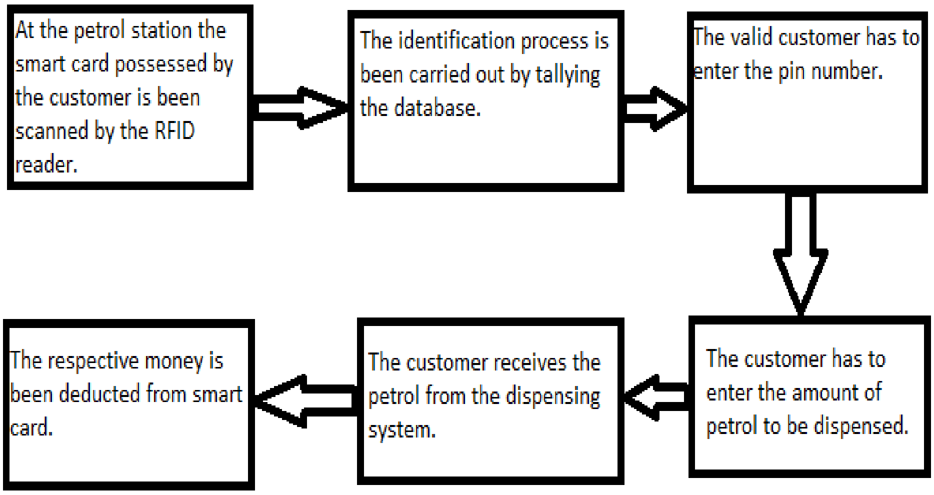

Fig 6 flow diagram of gsm-based manhole monitoring system

1. RFID Tag Identification

- **RFID Tag**: Every vehicle involved in the fuel dispensing process is assigned an RFID tag, which is typically an embedded chip attached to the vehicle. This RFID tag contains a unique identifier (UID) that can be read by an RFID reader.
- **RFID Reader**: The RFID reader installed at the petrol pump detects and reads the unique identifier from the RFID tag when the vehicle pulls into the fueling station. It sends this identifier to the microcontroller (e.g., Arduino) for processing.

2. Vehicle Authentication

- **Microcontroller Processing**: The microcontroller (Arduino Uno or similar) receives the RFID tag data from the RFID reader. The system checks this identifier against a pre-stored list of authorized RFID tags stored either in the microcontroller's memory or a centralized database.
- **Tag Authentication**: If the RFID tag matches an authorized entry, the system proceeds to the next step. If the tag is invalid or unrecognized, the system prompts an error

message (e.g., on an **LCD display**) and denies access to fuel dispensing.

3. User Input via Keypad

- **Fuel Amount Selection**:

  Once the RFID tag is authenticated, the system prompts the user to input the desired **fuel amount** (in liters) via a **keypad**. This can be either manually entered by the user or preset for specific vehicles based on a customer profile.

- **Additional Security (Optional)**:

  In some systems, a **PIN code** entry via the keypad can be required to further authenticate the transaction and ensure secure access to the fuel pump.

4. Fuel Dispensing Control

- **Relay Activation**: After the user confirms the fuel amount, the microcontroller sends a signal to a relay, which controls the fuel pump motor. The relay acts as a switch that connects or disconnects the power to the fuel pump.
- **Fuel Pump Motor Operation**: The fuel pump motor is activated to start the fuel dispensing process. The motor runs for a predefined period or until the requested fuel amount is dispensed. The pump dispenses fuel into the vehicle's fuel tank while continuously measuring the fuel dispensed.

5. Displaying Information

- **LCD Display**: Throughout the process, an LCD screen (16x2 or similar) displays relevant information, such as:
  - The status of the transaction (e.g., "Fuel Dispensing...")
  - The amount of fuel dispensed
  - The total cost of the fuel
  - Any error or status messages (e.g., "Invalid RFID Tag", "Transaction Completed")

CHAPTER 7

RESULTS AND DISCUSSION

An RFID-based petrol pump automation system streamlines fuel dispensing by enhancing efficiency, security, and convenience. It enables faster transactions through automated identification and payment using RFID cards, significantly reducing customer waiting times. The system ensures only authorized users access fuel, preventing unauthorized usage and minimizing fraud. Real-time monitoring provides accurate data on fuel dispensed and customer usage, along with detailed reports for inventory and sales tracking. Customers benefit from prepaid options and account linking, eliminating the need for cash or card payments. Additionally, the system reduces operational costs by minimizing labor requirements and optimizing fuel management. While initial installation may involve higher costs and maintenance, the long-term benefits, including increased throughput, error-free transactions, and improved customer satisfaction, make it a cost-effective and reliable solution for modern fuel stations.

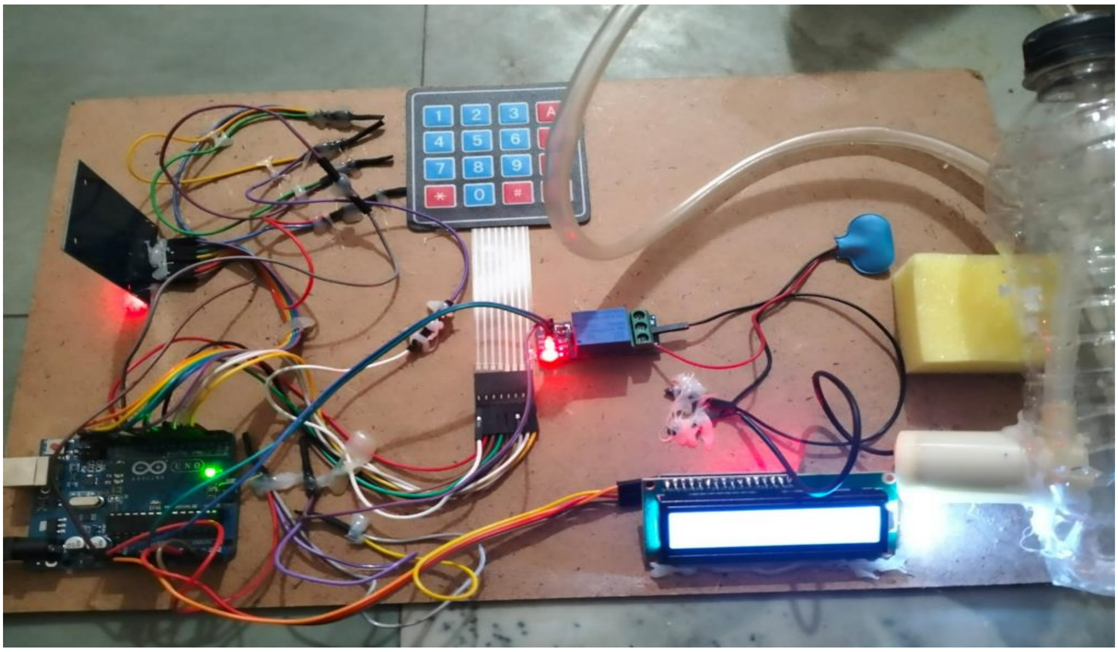

Fig 7.1 HARDWARE PICTURE DURING SIMULATION

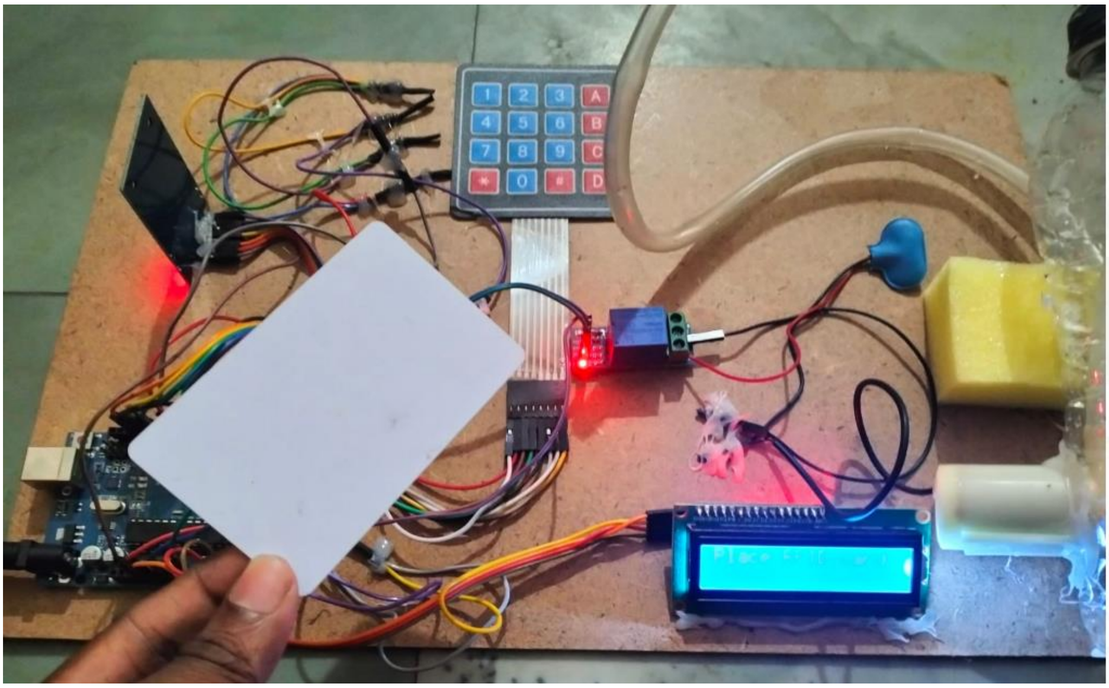

Fig 7.2 PICTURE DURING RFID CARD

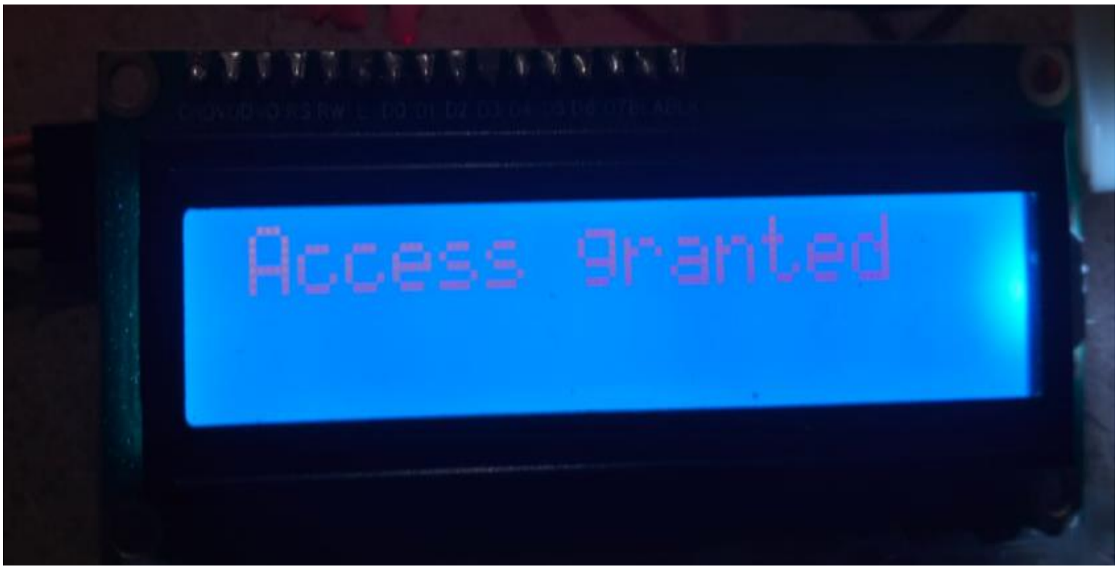

FIG 7.3 LCD DISPLAY WHEN RFID CARD IS ACCESSED

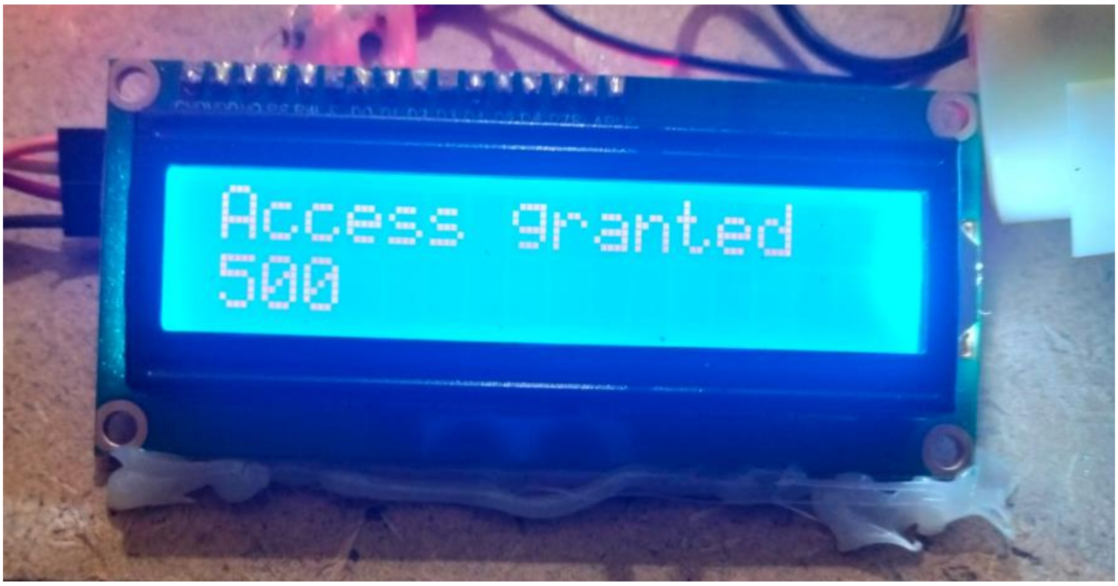

FIG 7.4 LCD DISPLAY WHEN AMOUNT IS ENTERED

FIG 7.5 SIMULATION RESULT

CHAPTER 8

ADVANTAGES & APPLICATIONS

8.1 Advantages:

1. Enhanced Security

- Authorized Access: Only registered users with valid RFID cards can access the fuel dispensing system, preventing unauthorized use.
- Transaction Records: Each transaction is logged, ensuring transparency and traceability.

2. Improved Efficiency

- Faster Transactions: RFID enables quick authentication and eliminates manual input, reducing waiting time.
- Automation: Automated fuel dispensing streamlines operations, reducing human intervention.

3. Cashless Payments

- Prepaid System: RFID cards can be linked to prepaid accounts, removing the need for cash or card payments.
- Convenience: Users can simply scan their cards to complete transactions.

4. Reduced Errors

- Accurate Dispensing: Automated systems ensure precise fuel quantities are dispensed.
- Minimized Human Error: Reduces errors in billing, fuel measurement, or manual data entry.

5. User-Friendly Interface

- LCD Display: Provides real-time information about fuel quantity, cost, and balance on the RFID card.
- Guided Process: The system guides users step-by-step, making it easy for first-time users.

6. Operational Cost Savings

- Reduced Workforce Requirements: Automation minimizes the need for on-site staff.

8.2 Applications

1. Commercial Fuel Stations

- Automates fuel dispensing and billing processes in public petrol pumps.
- Reduces the need for cash handling by enabling cashless payments via RFID cards.
- Enhances security and operational efficiency for high-volume transactions.

2. Private Fleet Management

- Used by companies with large fleets of vehicles to monitor and control fuel consumption.
- Ensures only authorized vehicles can access fuel, reducing fuel theft or misuse.
- Simplifies record-keeping and expense tracking for fleet operators.

3. Industrial Fueling Stations

- Deployed in industries requiring in-house fueling, such as mining, construction, and logistics.
- Tracks fuel usage per vehicle or equipment, aiding in cost analysis and inventory management.

4. Government and Public Sector

- Used for official vehicles to ensure transparency and accountability in fuel usage.
- Suitable for public transportation systems like buses or municipal service vehicles.

5. Agriculture Sector

- Supports fuel management for tractors, harvesters, and other agricultural equipment.
- Ensures accurate tracking of fuel usage during field operations.

CHAPTER 9

CONCLUSION & FUTURE SCOPE

9.1 Conclusion

In conclusion, an RFID-based petrol pump automation system offers a modern, efficient, and secure solution for fuel dispensing and management. By automating processes such as identification, payment, and record-keeping, it enhances operational efficiency and customer satisfaction while reducing human error and labor costs. The system's ability to provide real-time monitoring and detailed reporting improves inventory management and fraud prevention. Though the initial setup cost may be high, the long-term benefits, including faster transactions, enhanced security, and scalability, make it a valuable investment for fuel stations.

8.2 Future scope

The future scope of RFID-based petrol pump automation systems is vast, driven by advancements in technology and growing demand for efficiency and security. Additionally, the technology may enhance customer experience through personalized loyalty programs, subscription-based services, and multi-fuel compatibility, including electric vehicle (EV) charging and hydrogen fueling. Cloud-based platforms could enable centralized management of multiple stations, while AI and big data analytics might optimize fuel operations, predict demand, and track environmental impact. RFID-based petrol pump automation systems are poised to transform fueling infrastructure, offering greater convenience, sustainability, and operational efficiency.

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APPENDIX

```
#include <SPI.h>
#include <RFID.h>
#include <Keypad.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// RFID setup
#define SS_PIN 10
#define RST_PIN 9
RFID rfid(SS_PIN, RST_PIN);
String rfidCard;

// Keypad setup
const byte ROWS = 4; // Number of rows in the keypad
const byte COLS = 4; // Number of columns in the keypad

// Define the keymap
char keys[ROWS][COLS] = {
  {'1', '2', '3', 'A'},
  {'4', '5', '6', 'B'},
  {'7', '8', '9', 'C'},
  {'*', '0', '#', 'D'}
};

// Define the pin connections of the keypad
byte rowPins[ROWS] = {9, 8, 7, 6}; // Connect to the row
pinouts of the keypad
byte colPins[COLS] = {5, 4, 3, 2}; // Connect to the column
pinouts of the keypad
```

```
// Create a Keypad object
Keypad keypad = Keypad(makeKeymap(keys), rowPins,
colPins, ROWS, COLS);

String inputString = ""; // String to store the input
characters
int remainingAmount = 1000; // Initial value to subtract
from
const int motorPin = A0; // Pin connected to the motor

// LCD setup
LiquidCrystal_I2C lcd(0x27, 16, 2); // I2C address 0x27, 16
column and 2 rows

// Define valid RFID serial numbers
String validRFIDs[] = {"243 254 81 53", "46 48 157 196"}; //
Add more serial numbers as needed

void setup() {
  Serial.begin(9600);
  Serial.println("Starting the RFID Reader...");
  SPI.begin();
  rfid.init();
  pinMode(motorPin, OUTPUT); // Set motor pin as an
output
  digitalWrite(motorPin, HIGH); // Ensure motor is off
initially

  // Initialize the LCD
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
```

```
  lcd.print("Place RFID card");
}

void loop() {
  while (true) {
    if (rfid.isCard()) {
      if (rfid.readCardSerial()) {
        // Read the RFID card serial number
        rfidCard = String(rfid.serNum[0]) + " " + String(rfid.serNum[1]) + " " + String(rfid.serNum[2]) + " " + String(rfid.serNum[3]);
        Serial.println(rfidCard);
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("RFID: ");
        lcd.setCursor(0, 1);
        lcd.print(rfidCard);

        // Check if the RFID card is valid
        if (isValidRFID(rfidCard)) {
          // Access granted
          Serial.println("Access granted");
          lcd.clear();
          lcd.setCursor(0, 0);
          lcd.print("Access granted");
          delay(1000);

          // Get keypad input and process it
          getKeypadInputAndProcess();
          break; // Exit the while loop to reset the system
        } else {
          Serial.println("Access NOT granted");
```

```
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Access NOT granted");
        delay(1000);
      }
    }
    rfid.halt(); // Stop the RFID reading
  }
 }

 // Ensure RFID reader is reinitialized properly after processing
 reinitializeRFIDReader();
}

// Function to handle keypad input and process it
void getKeypadInputAndProcess() {
 while (true) {
  char key = keypad.getKey(); // Get the pressed key
  if (key != NO_KEY) {
   if (key == 'A') {
    Serial.println();
    Serial.println("Enter button pressed");
    int integerValue = inputString.toInt();
    int newRemainingAmount = remainingAmount - integerValue;
    Serial.print("Remaining amount: ");
    Serial.println(newRemainingAmount);

    if (integerValue > 0 && integerValue <= remainingAmount) {
     pumpWater(integerValue);
```

```
          remainingAmount = newRemainingAmount;
          lcd.clear();
          lcd.setCursor(0, 0);
          lcd.print("Remaining: ");
          lcd.setCursor(0, 1);
          lcd.print(newRemainingAmount);
        } else {
          Serial.println("INSUFFICIENT BALANCE!!!");
          lcd.clear();
          lcd.setCursor(0, 0);
          lcd.print("INSUFFICIENT");
          lcd.setCursor(0, 1);
          lcd.print("BALANCE!!!");
          remainingAmount = 1000; // Reset remaining
amount
        }
        inputString = ""; // Clear the input string for the next
input
        delay(2000); // Ensure message is displayed long
enough
        break; // Exit the while loop to restart from the initial
state
      } else if (key == 'B') {
        Serial.println("Resetting system...");
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Resetting system...");
        inputString = ""; // Clear the input string
        delay(2000); // Ensure message is displayed long
enough
        break; // Exit the while loop to restart from the initial
state
```

```
      } else {
        inputString += key; // Append the pressed key to the
input string
        Serial.print(key);
        lcd.setCursor(0, 1);
        lcd.print(inputString);
      }
    }
    delay(100);
  }
}

// Function to check if an RFID is valid
bool isValidRFID(String rfid) {
  for (int i = 0; i < sizeof(validRFIDs) / sizeof(validRFIDs[0]);
i++) {
    if (rfid == validRFIDs[i]) {
      return true;
    }
  }
  return false;
}

// Function to pump water based on the input value
void pumpWater(int amount) {
  int duration = map(amount, 1, 1000, 500, 5000); // Map
input amount to duration in milliseconds
  Serial.print("Pumping petrol for ");
  Serial.print(duration);
  Serial.println(" milliseconds");
  lcd.clear();
  lcd.setCursor(0, 0);
```

```
  lcd.print("Pumping petrol for");
  lcd.setCursor(0, 1);
  lcd.print(duration);
  lcd.print(" ms");

  digitalWrite(motorPin, LOW); // Turn on the motor
  delay(duration); // Pump water for the specified duration
  digitalWrite(motorPin, HIGH); // Turn off the motor

  Serial.println("Petrol pumping complete");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Pumping complete");
  delay(2000); // Ensure message is displayed long enough
}

// Function to reinitialize the RFID reader
void reinitializeRFIDReader() {
  SPI.end();
  delay(100); // Ensure there is a small delay for proper
reinitialization
  SPI.begin();
  rfid.init();
  Serial.println("RFID reader reinitialized");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Petrol Dispensed...");
  delay(2000); // Ensure message is displayed long enough
}
```